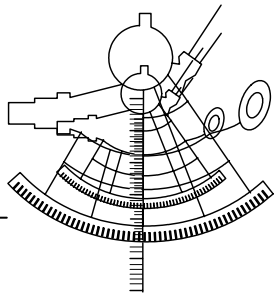
European innovation scoreboard - innovation and economic performance report

European Trend Chart on Innovation



European Innovation Scoreboard 2005

Innovation and Economic performance

February 1, 2006

The present report was prepared by **Hugo Hollanders and Anthony Arundel (MERIT).** The information contained in this report has not been validated in detail by either the Member States or the European Commission.

European Commission
Enterprise Directorate-General

A discussion paper from the Innovation/SMEs Programme

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EXECUTIVE SUMMARY

The report on *Innovation and Economic performance* briefly explores possible interactions between various measures of innovation performance (Summary Innovation Index and key innovation dimensions) and various measures of economic performance (per capita GDP, labour productivity and employment growth). Statistical evidence for significant positive correlations is weak. A first simple estimate of the elasticity of the SII and per capita GDP results in a value of between 100 and 400; a 0.01 point increase of the SII would thus lead to an increase of between 100 and 400 euros of per capita GDP. This elasticity gives an indication of the possible impact on per capita GDP of increases in innovation performance but the elasticity should be interpreted with care.

Research inputs as measured by R&D expenditures are significantly correlated with per capita GDP, however the duration after which R&D investments impact on GDP is hardly measurable. At the sector level we do find a significant and positive correlation between the composite innovation sector index (ISI) and economic performance. More innovative sectors tend to have higher growth rates of labour productivity.

1. INTRODUCTION

The justification for policy actions to support innovation is that innovation is partly responsible for improvements in the quality of life and in quantitative measures of well-being such as higher GDP per capita, productivity and economic growth.

The link between innovation and growth has been extensively explored from both a theoretical and an empirical perspective. Although several different measures of innovation have been used in empirical research, including R&D spending, patenting, and the technological balance of payments, most empirical research has focused on the effect of innovation on productivity, either at the firm, industry or country level. The literature on this issue[1] finds that innovation has a significant effect on productivity, whether measured by R&D spending, patenting or innovation counts. The OECD Growth Project[2] has explored the possible sources of divergence in the levels of GDP per capita among OECD countries. Although an individual factor cannot be identified as the main source of growth divergences, innovation and technology are pointed out as significant factors in increased growth performance.

[1] For a review of this literature, see Mairesse, J. and Mohnen, P. (1995). *R&D and productivity: a survey of the econometric literature*, Université du Québec: mimeo; or Cameron, G. (1998) *Innovation and Growth: a survey of the empirical literature* (manuscript).

The EIS 2002 Methodology Report[3] explored possible dependencies between the 2002 innovation indicators, the 2002 SII and three macro-economic variables at the national level: 2000 GDP per capita, 2001 hourly labour productivity and the growth in total employment between 2000 and 2001. Two, three, and five-year time lags were used when possible, to allow adequate time for innovation activities to influence macro-economic conditions. None of the correlations using the SII were statistically significant, while only a few of the correlations for individual indicators were significant.

This report provides in section 2 an update of the EIS 2002 analysis by providing graphical and statistical analyses of the links between innovation performance and economic performance. Section 2.1 takes a closer look at the link between the Summary Innovation Index (SII), the composite indexes for Input, Output, Innovation drivers, Knowledge creation, Innovation and entrepreneurship, Applications and Intellectual property and per capita GDP. Section 2.2 explores the elasticity of the SII on per capita GDP. Section 2.3 repeats section 2.1 but explored possible links between innovation performance and labour productivity, both per employee and per hour. Section 2.4 explores the correlation between the SII and the unemployment rate and employment growth. Section 2.5 explores correlations between research inputs – total, public and private – and per capita GDP. Section 3 explores the correlation between innovation performance and industrial performance. Section 4 provides a summary of an analysis between innovation and economic performance at the sector level from the EIS 2005 report on *European Sector Innovation Scoreboards*.

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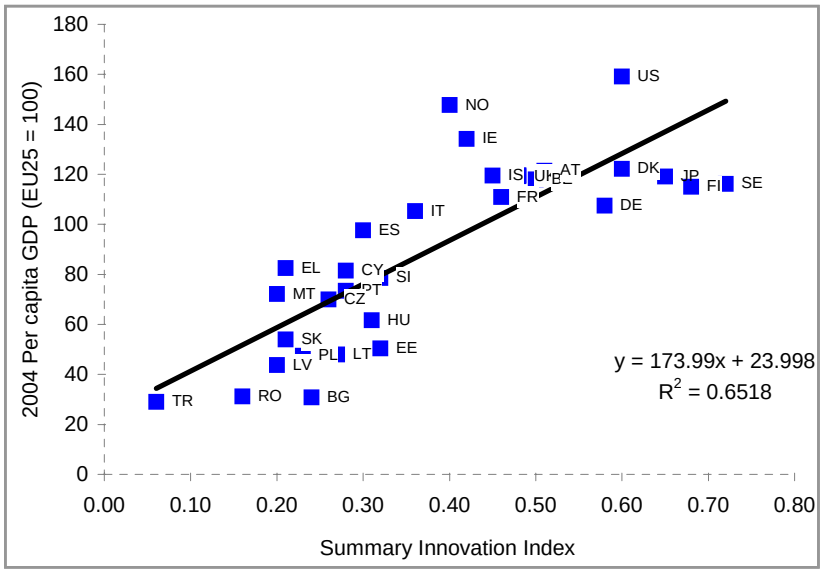
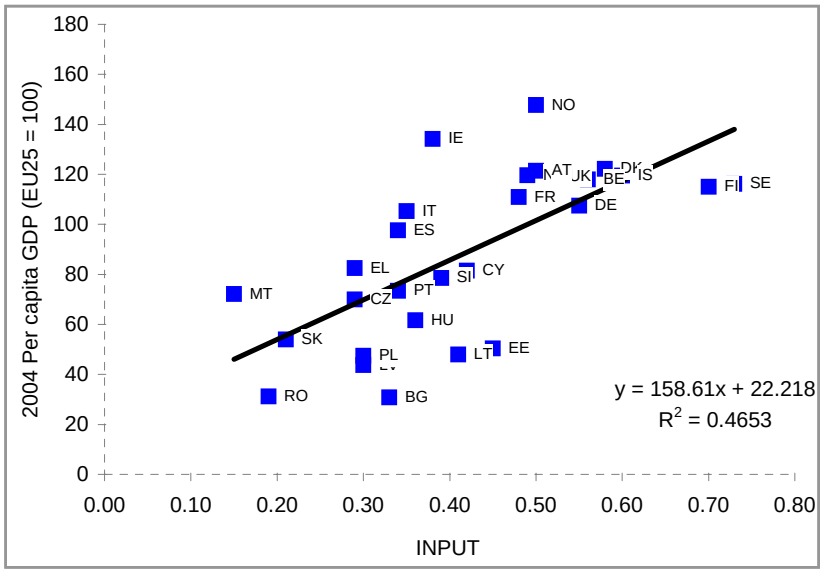
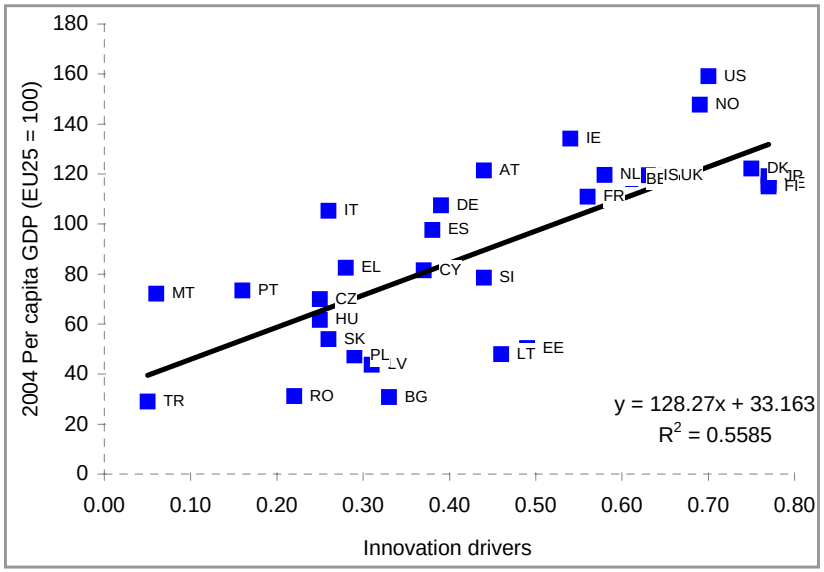
[2] http://www.oecd.org/subject/growth. See the report: *A new Economy? The Changing Role of Innovation and Information Technology in Growth*, OECD 2000.

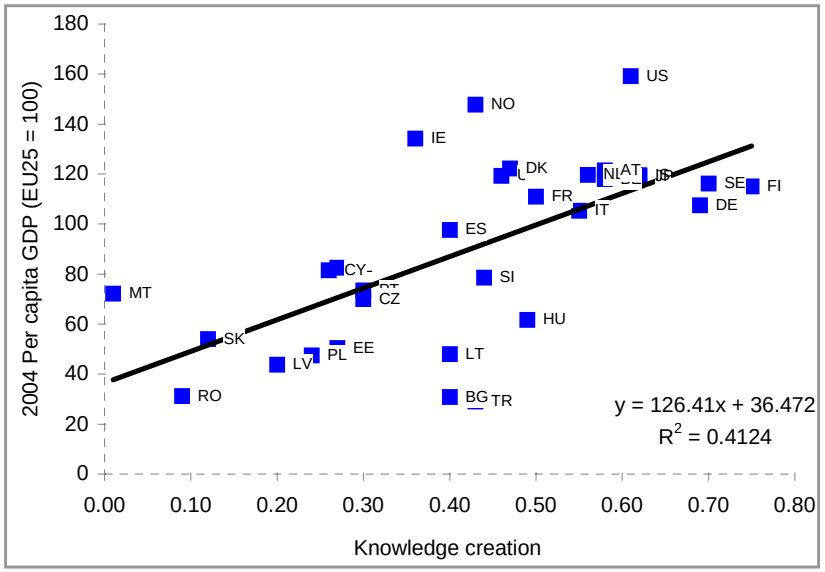
[3] http://194.78.229.48/extranettrend/reports/documents/report6.pdf

Figure 1 Innovation and economic performance: 2004 per capita GDP and SII, Input, Output and Key dimensions









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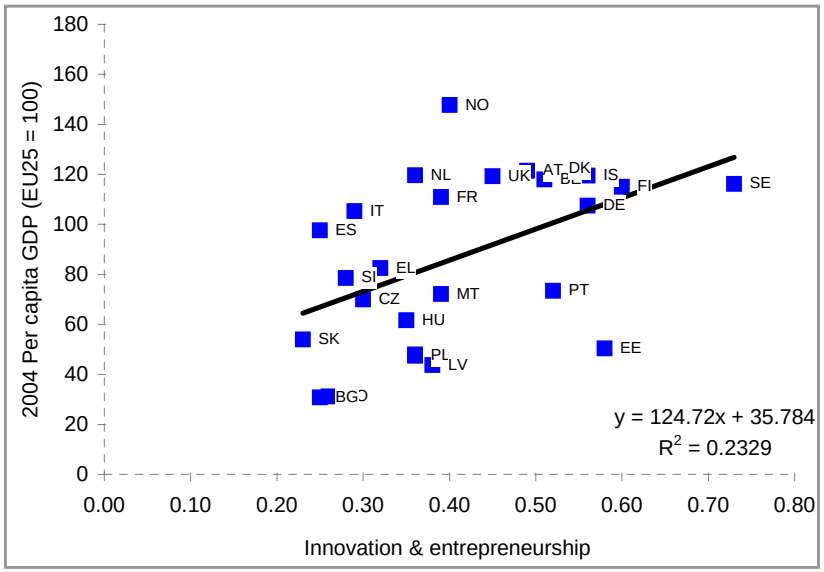
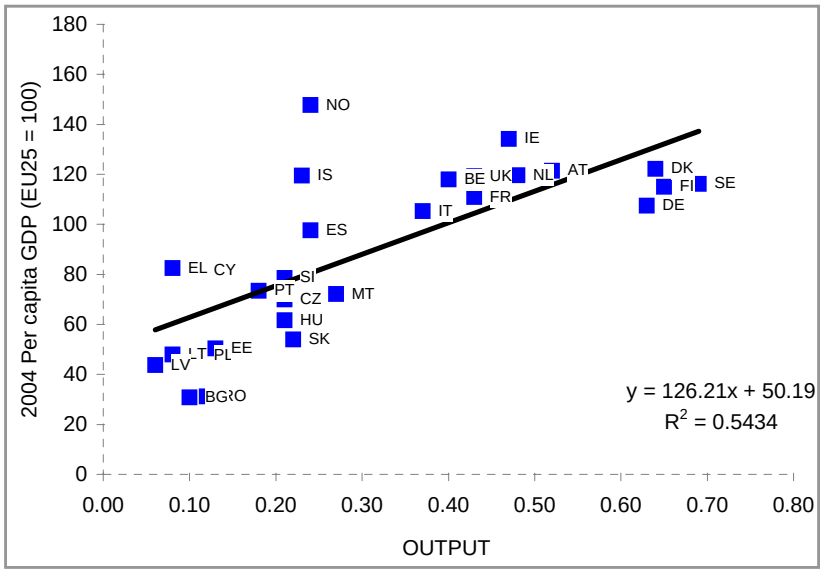
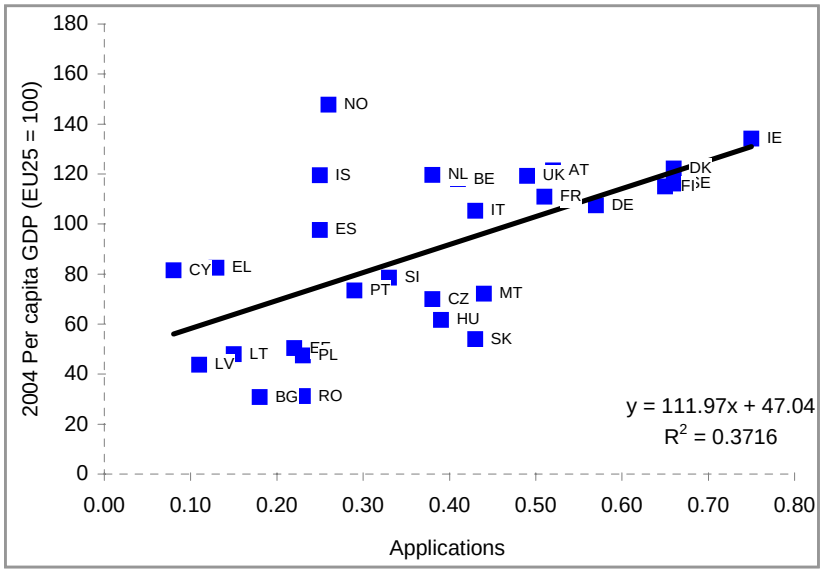






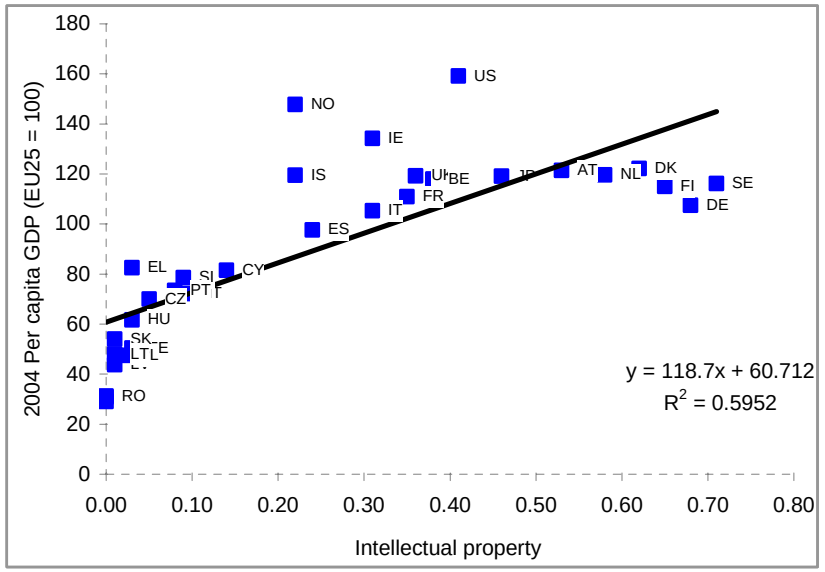


Figure 2 SII growth and per capita GDP growth

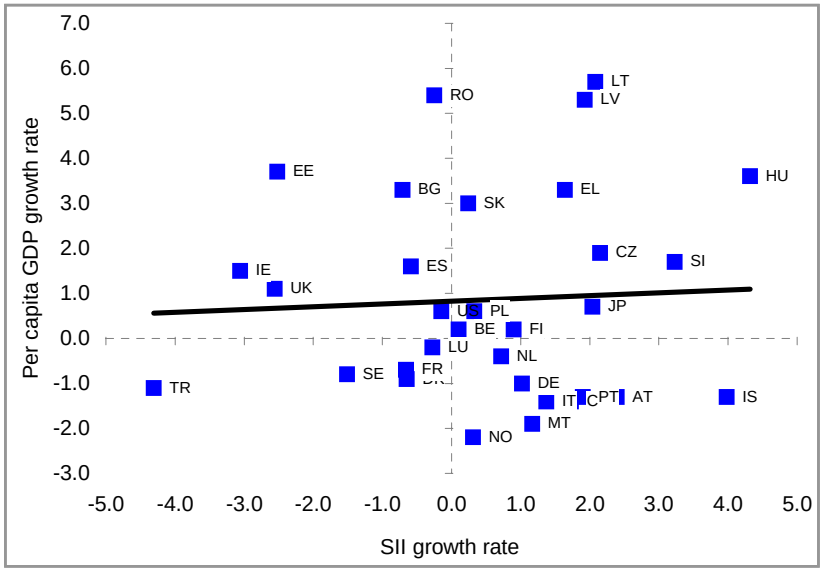


Figure 3 SII and per capita GDP growth

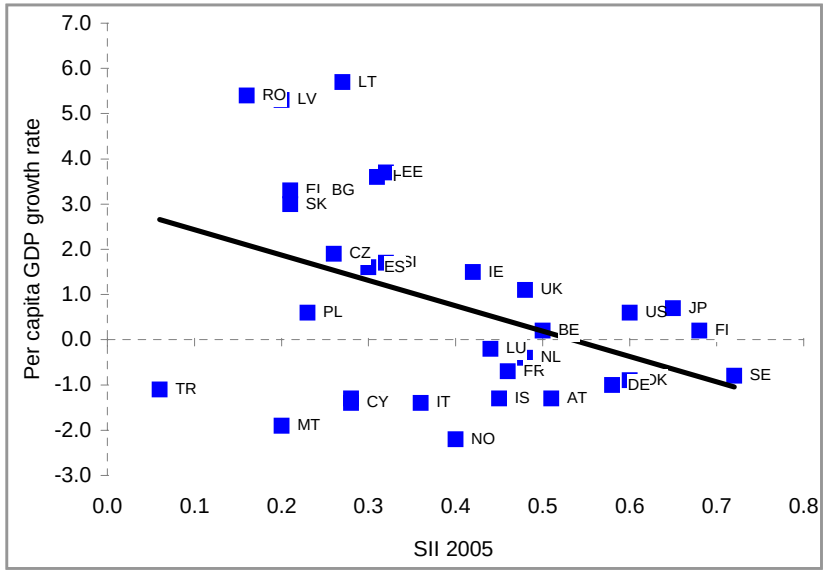


Figure 4 SII and incremental per capita GDP growth

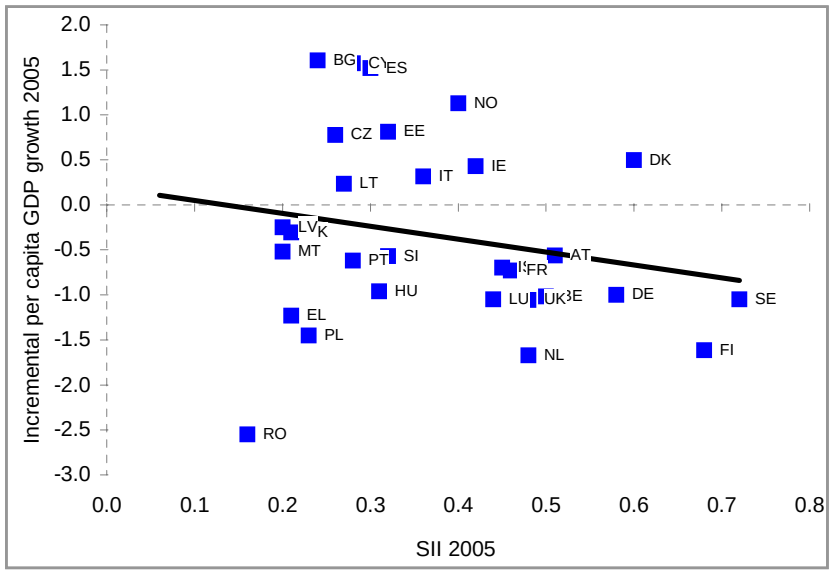
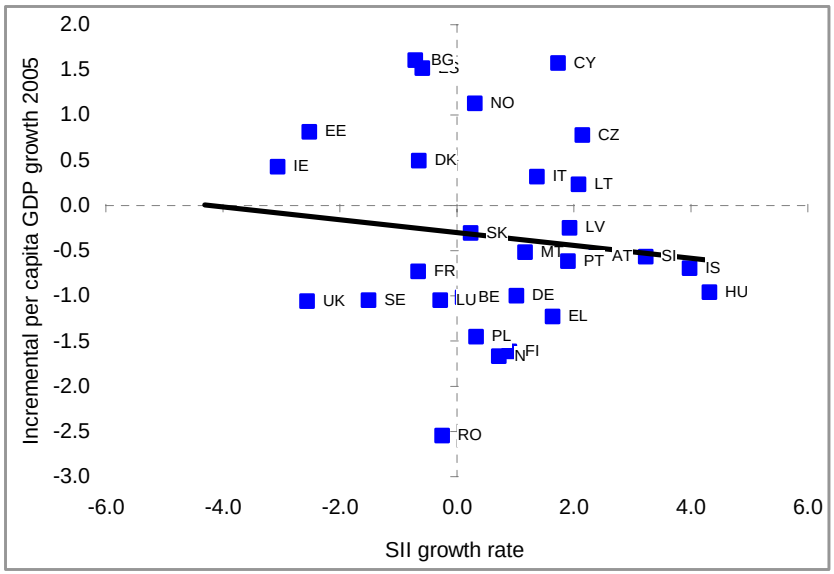


Figure 5 SII growth and incremental per capita GDP growth



2. INNOVATION AND ECONOMIC PERFORMANCE

2.1 INNOVATION AND PER CAPITA GDP

At a first glance, there appears to be a positive link between the SII and the composite indicators measuring innovation performance on inputs, outputs, innovation drivers, knowledge creation, innovation and entrepreneurship, applications and intellectual property and 2004 per capita GDP (Figure 1). However, this positive link is purely due to the fact that the set of countries includes both 'high-income' and 'low-income' countries. Within the group of high-income countries there is no link between the SII and 2004 per capita GDP.

As shown in Figure 2, there is no significant correlation between the growth rate of the SII and the growth rate of per capita GDP.

Innovation performance and per capita GDP growth are not positively linked (Figure 3). More innovative countries appear to have grown at a slower pace than less innovative countries.

Although innovation performance has no direct positive impact on per capita GDP growth, it might have an indirect positive effect by increasing this growth rate. However, as shown in Figure 4, the correlation between the SII 2005 and incremental per capita GDP growth – defined as the change in the growth rate between two years – is also negative. The same holds for the correlation between the SII growth rate and incremental per capita GDP growth.

2.2 ELASTICITY OF INNOVATION

A panel database was constructed combining 2003-2005 SII data with 2002-2006 GDP per capita data as shown in Table 1 obtaining per country 9 observations.

Table 1 Panel database

	Per capita GDP 2002	Per capita GDP 2003	Per capita GDP 2004	Per capita GDP 2005	Per capita GDP 2006
SII 2003	Obs #1	Obs #2	Obs #3	---	---
SII 2004	---	Obs #4	Obs #5	Obs #6	---
SII 2005	---	---	Obs #7	Obs #8	Obs #9

A visual inspection of the scatter plot of the SII data and per capita GDP (Figure 6) first reveals the fact that Luxembourg is a clear outlier with far above average per GDP values. Luxembourg is thus excluded from the panel database. A second fact is that we can distinguish between groups of countries, those to the left of the dashed line and those to the right of the dashed line. The first group includes all new member states, Greece, Portugal, Bulgaria, Romania and Turkey. The second group includes 13 EU15 countries, Iceland, Norway, Japan and the US. To capture the distinction between these two groups, a dummy variables was added to the database, where the dummy takes a value of 1 if the country belongs to the first group and a value of 0 if the country belongs to the second group. This dummy is used to take into account that the relation between the SII and per capita GDP is

different within these two groups. Table 2 summarizes the regression results for four simple linear regressions between per capita GDP and the SII.

Figure 6 Innovation performance and per capita GDP – panel data

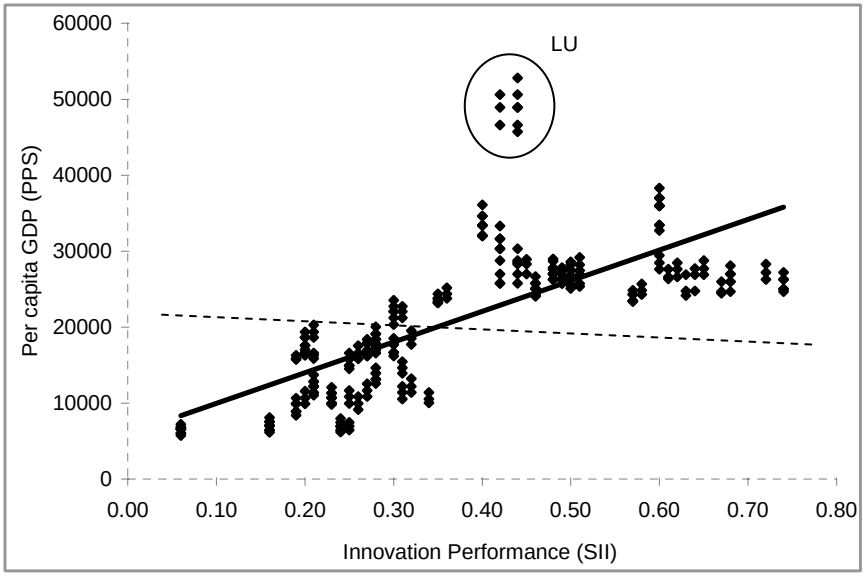


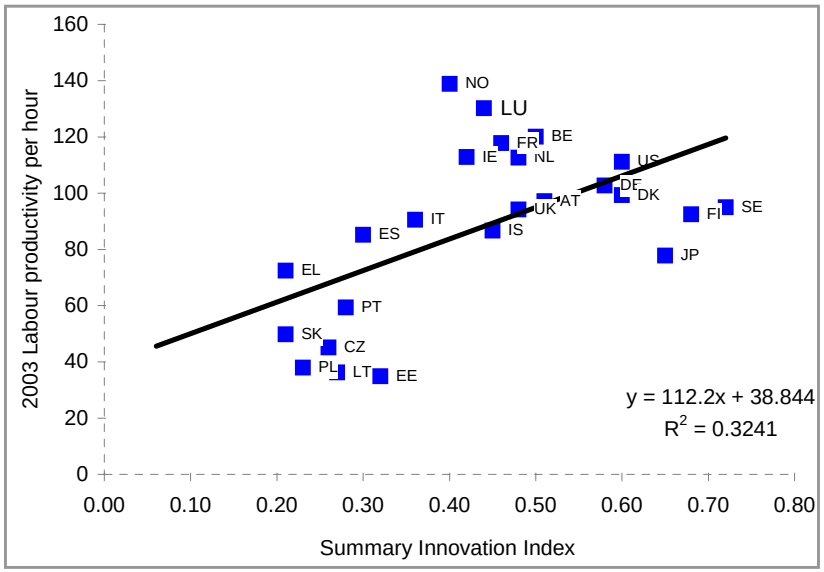
Table 2 Regression results between per capita GDP and SII

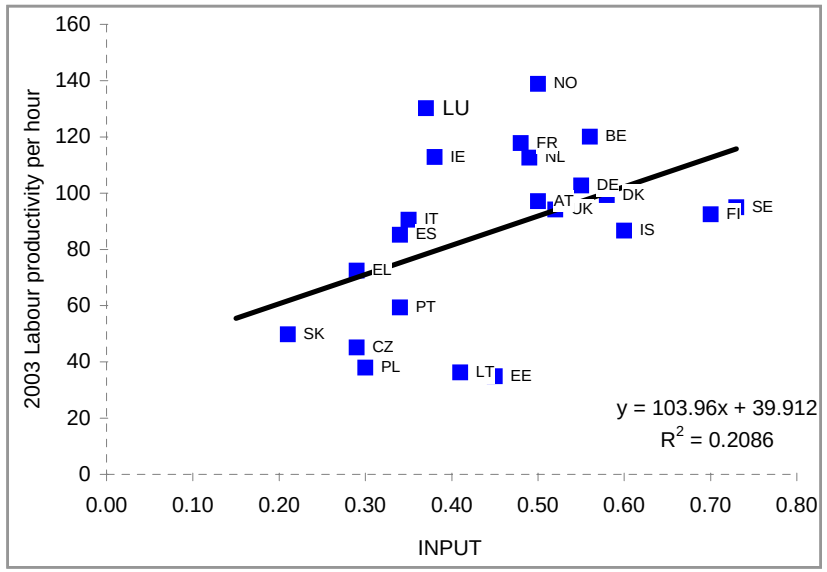
	Constant	Coefficient SII	Adjusted R^2
No dummy	5725	38725 (22.169) ***	0.638
Dummy	21843	10599 (4.465) ***	0.791

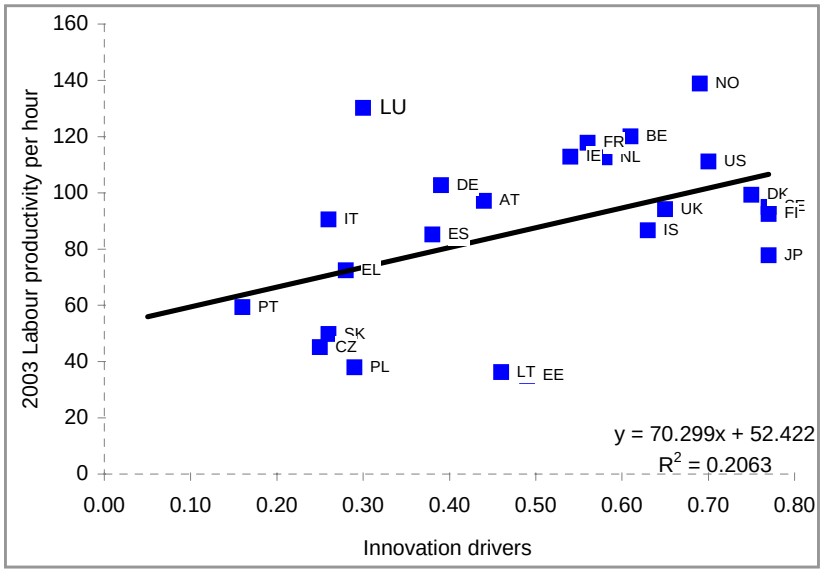
***/**/* Coefficient is significant at the 1%-level/5%-level/ 10%-level

The coefficient for the SII from the regressions can be used as a proxy for the elasticity of the SII on per capita GDP. A 0.01 point increase in the SII would lead to an increase in per capita GDP of about 100 to 400 euros. But this result should be interpreted with care, as it is highly dependent on the number of countries included (adding Luxembourg would raise the elasticity) and the use of the country dummy. The regression without a dummy gives an elasticity almost 4 times as high as the regression including a dummy.

Figure 7 Economic and innovation performance: 2003 Labour productivity per hour and SII, Input, Output and Key dimensions







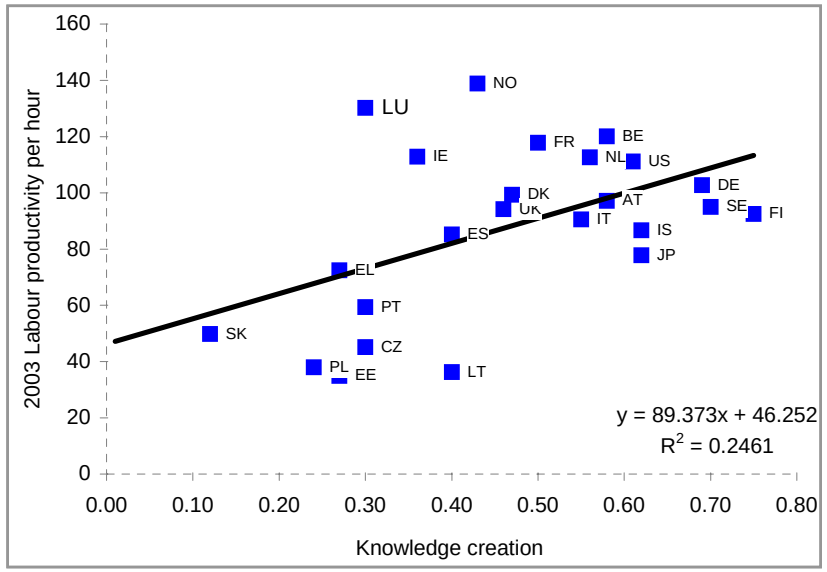
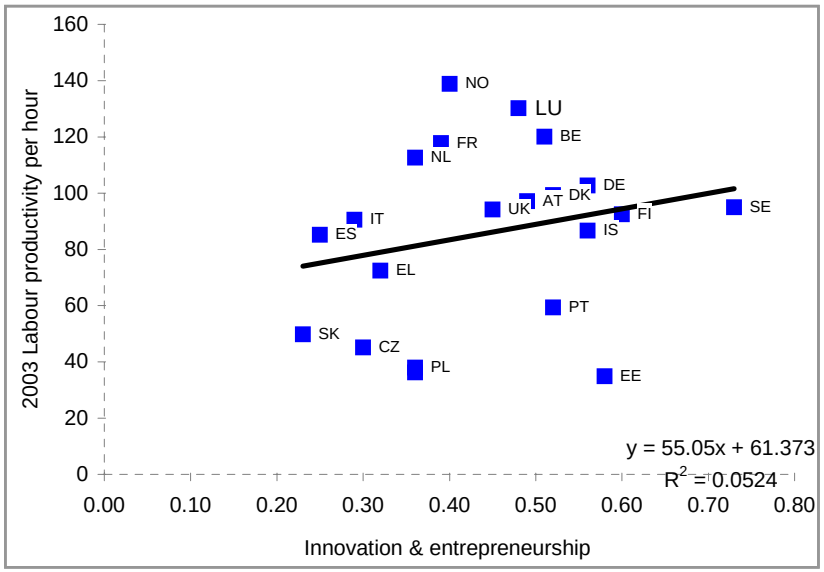
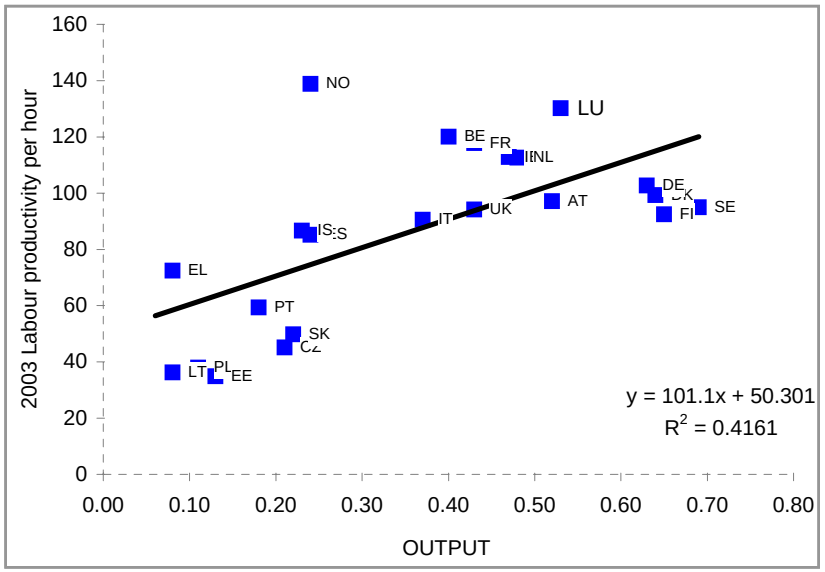
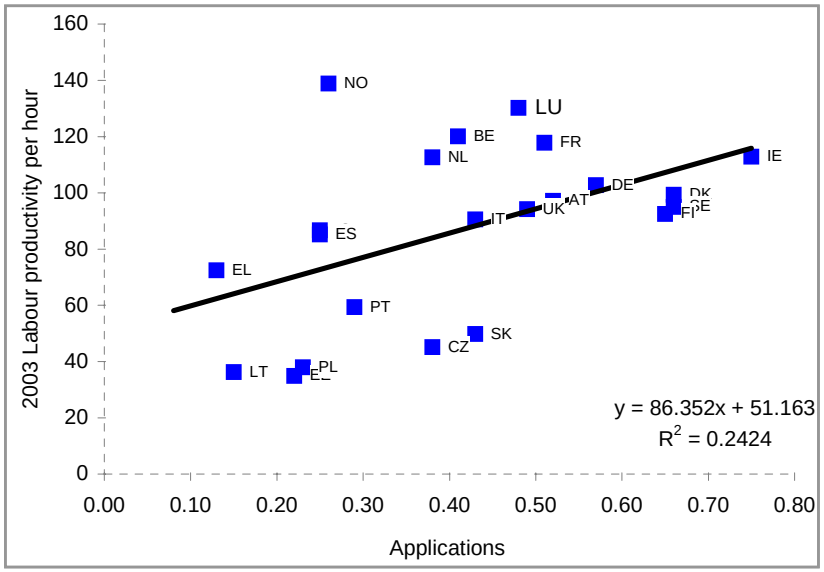


Figure 7 Economic and innovation performance: 2003 Labour productivity per hour and SII, Input, Output and Key dimensions







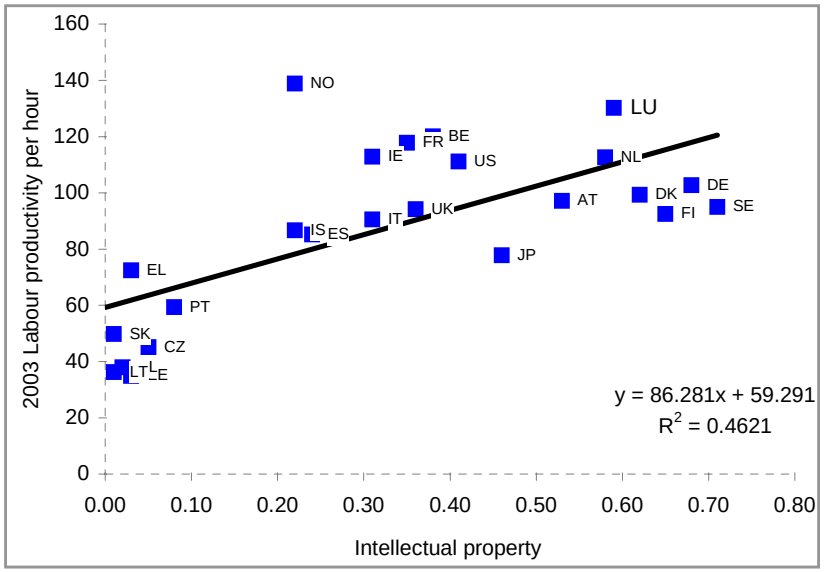
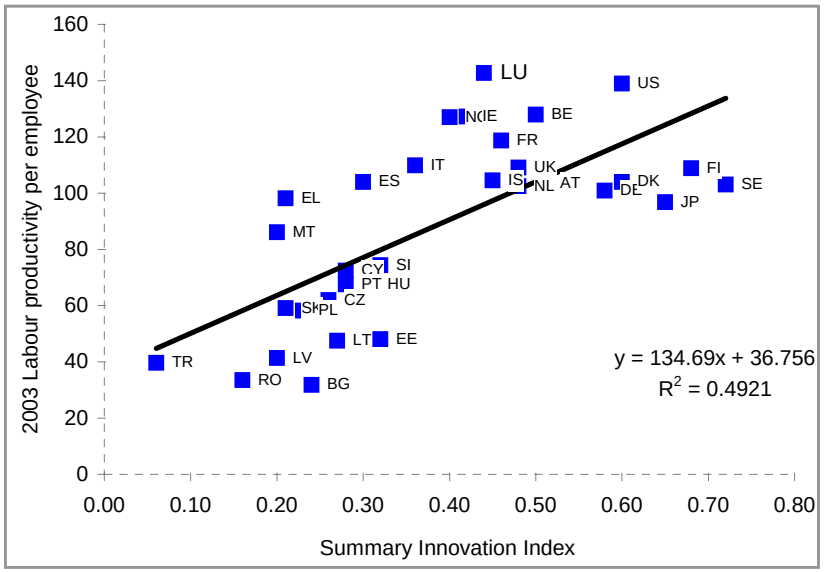
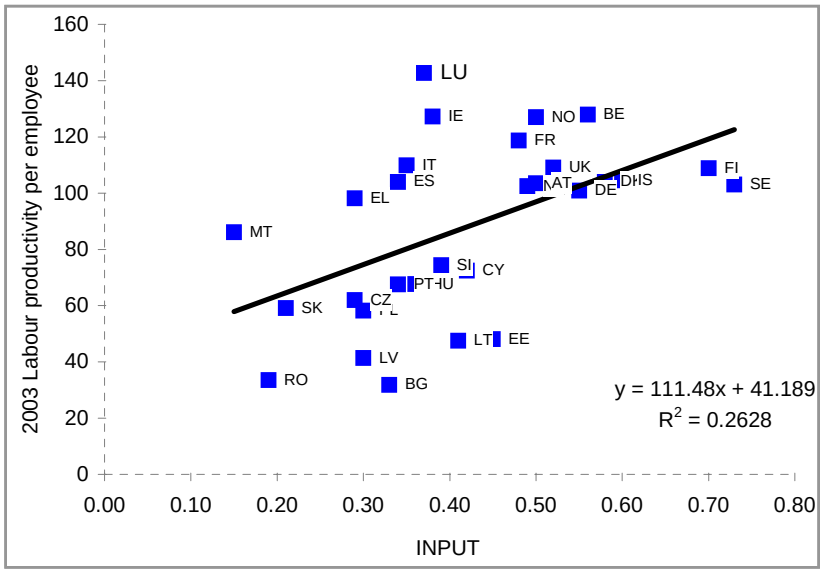
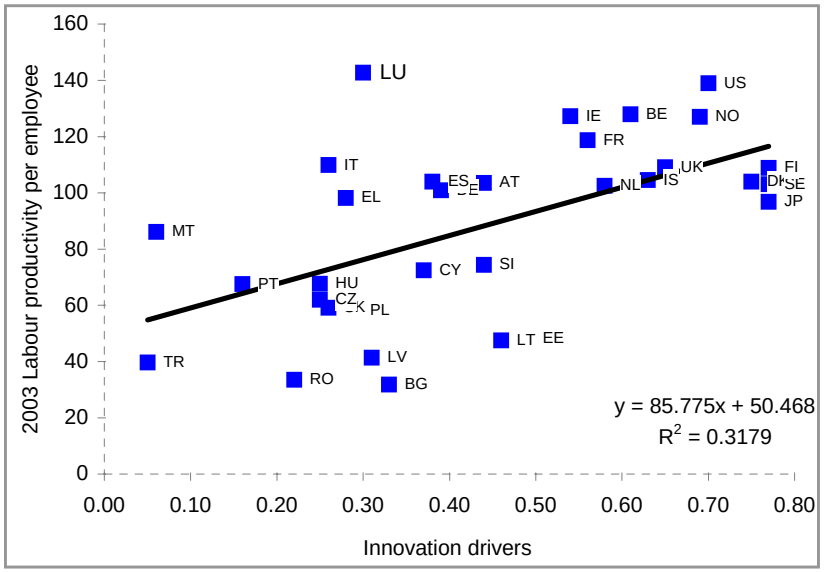


Figure 8 Economic and innovation performance: 2003 Labour productivity per employee and SII, Input, Output and Key dimensions







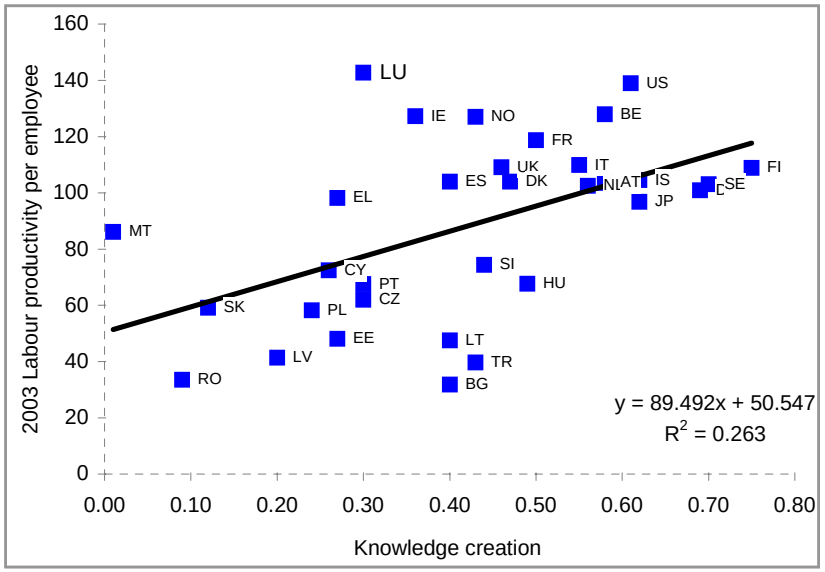
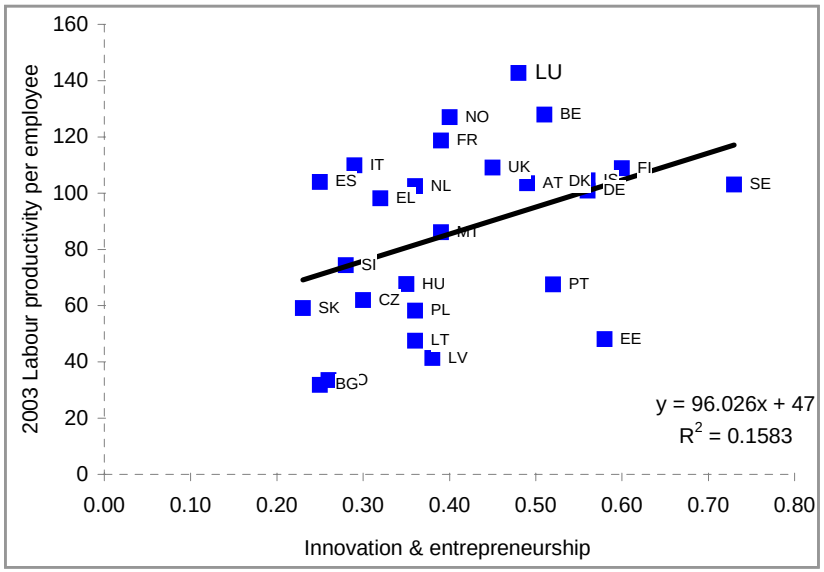
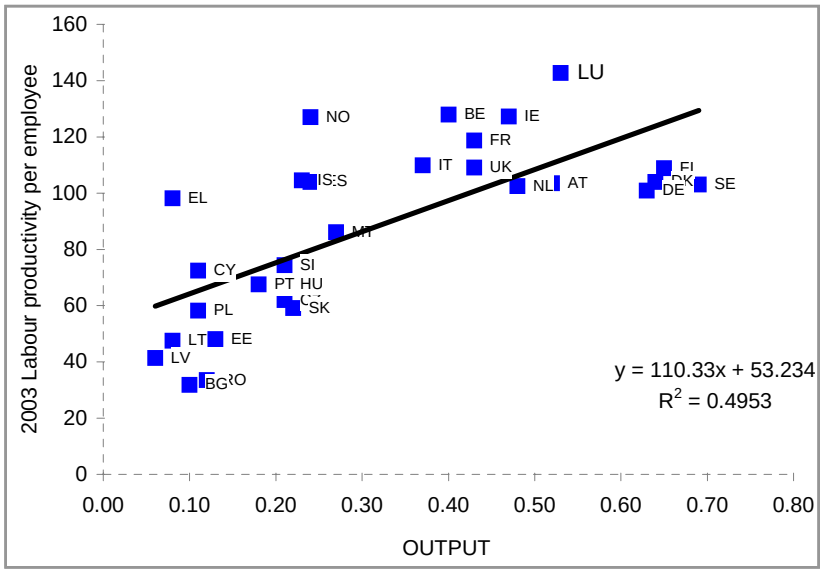
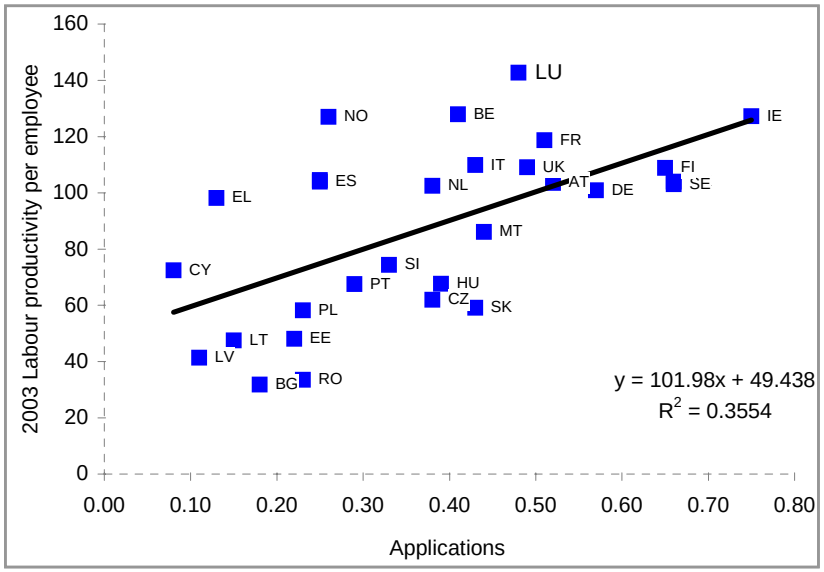
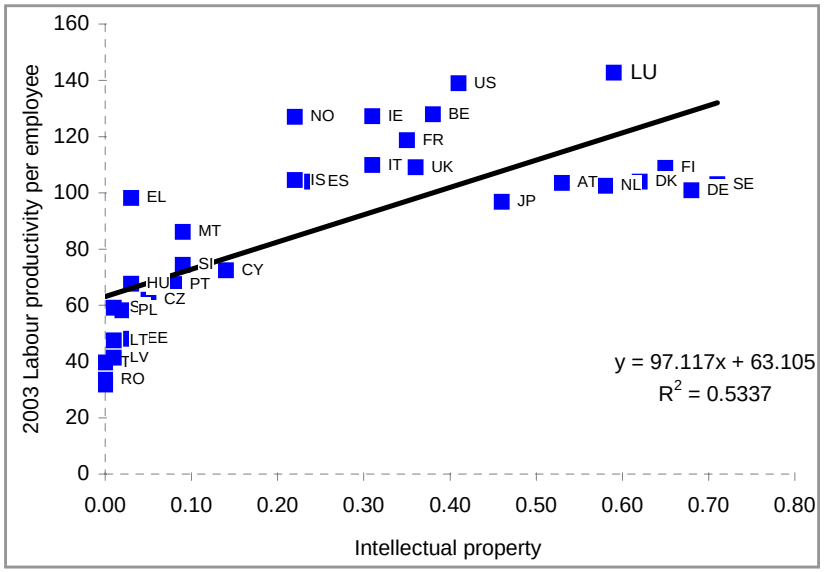


Figure 8 Economic and innovation performance: 2003 Labour productivity per employee and SII, Input, Output and Key dimensions









2.3 INNOVATION AND LABOUR PRODUCTIVITY

At a first glance, there appears to be a positive link between the SII and the composite indicators measuring innovation performance on inputs, outputs, innovation drivers, knowledge creation, innovation and entrepreneurship, applications and intellectual property and 2003 labour productivity, whether measures per hour (see Figure 7) or per employee (see Figure 8).

There is however no significant correlation between the growth rate of the SII and the growth rate labour productivity (Figure 9).

Figure 9 SII growth and labour productivity growth

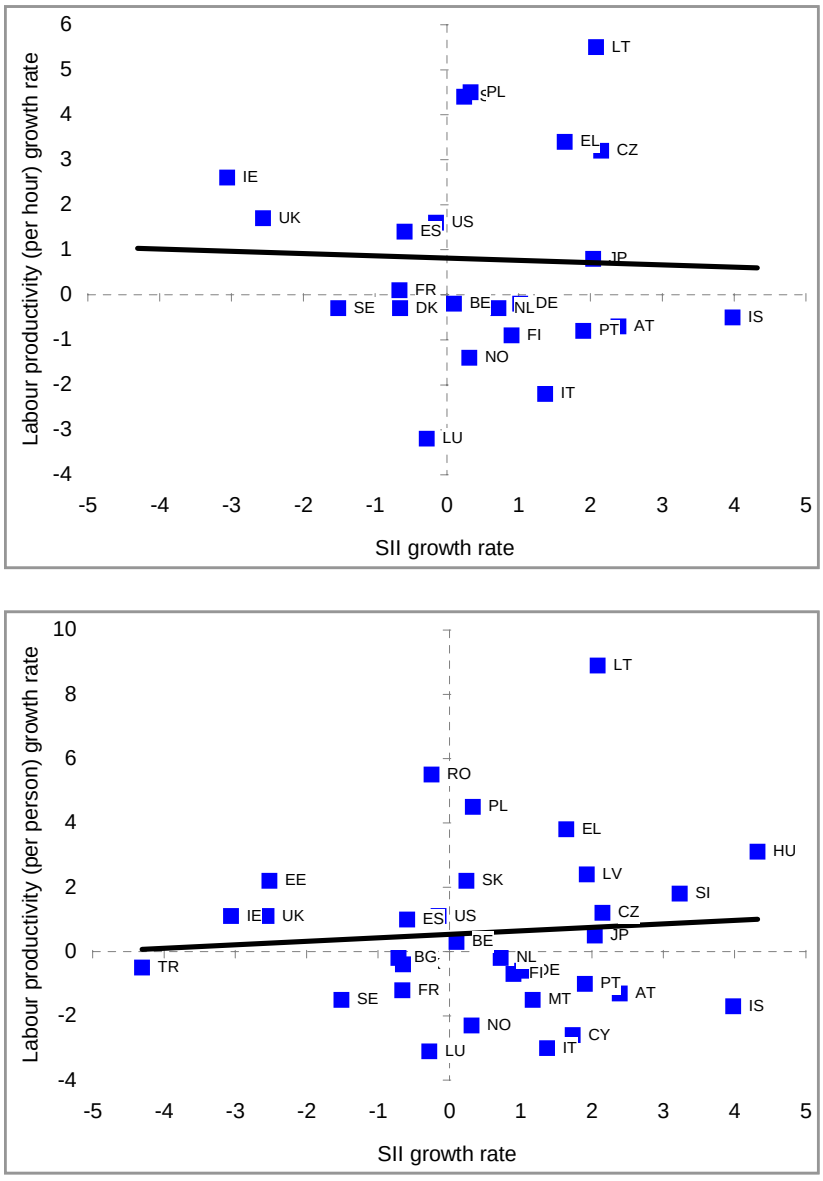


Figure 10 SII and unemployment rate

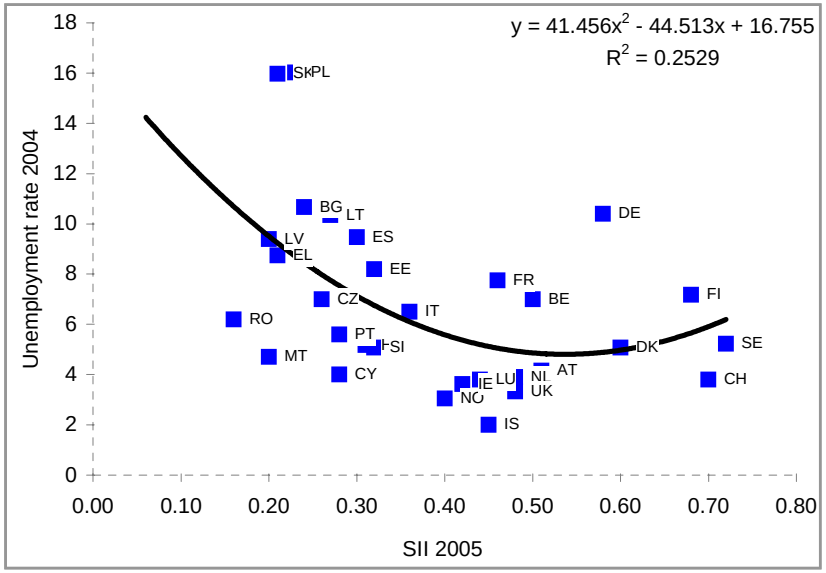


Figure 11 SII and change in unemployment

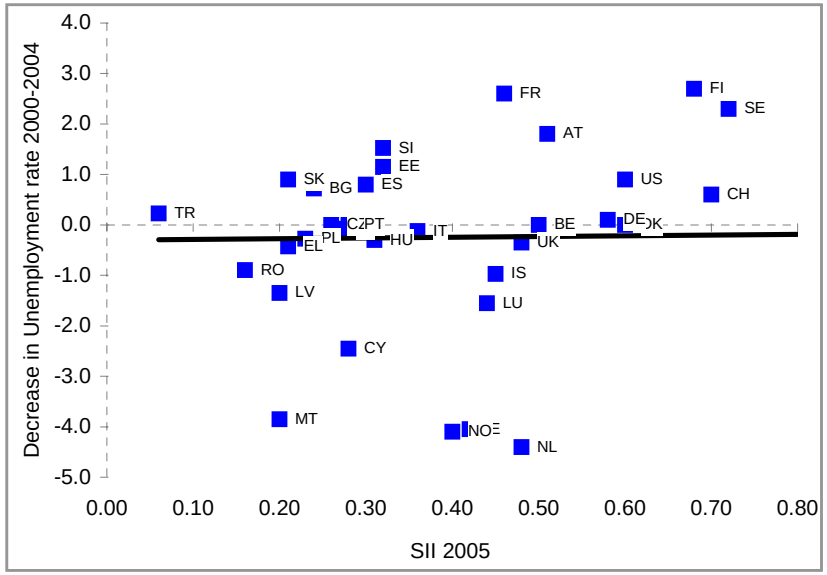


Figure 12 SII and employment growth

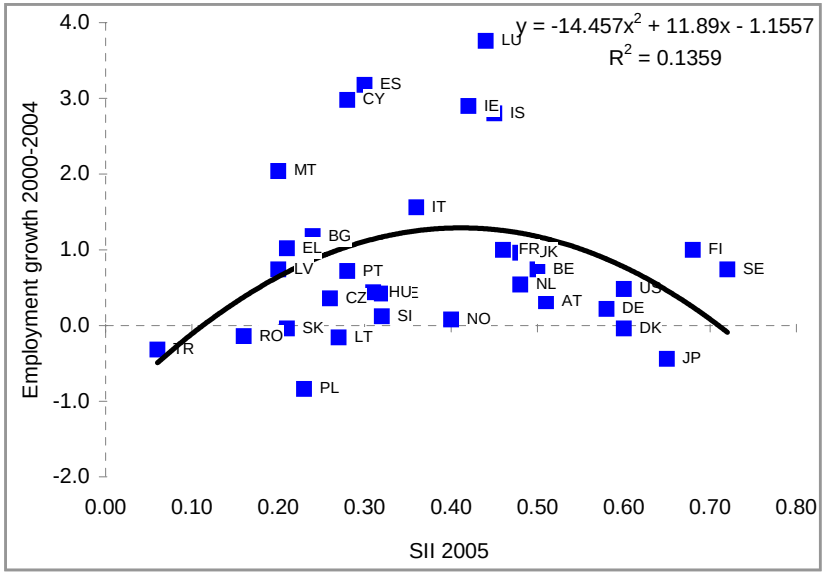
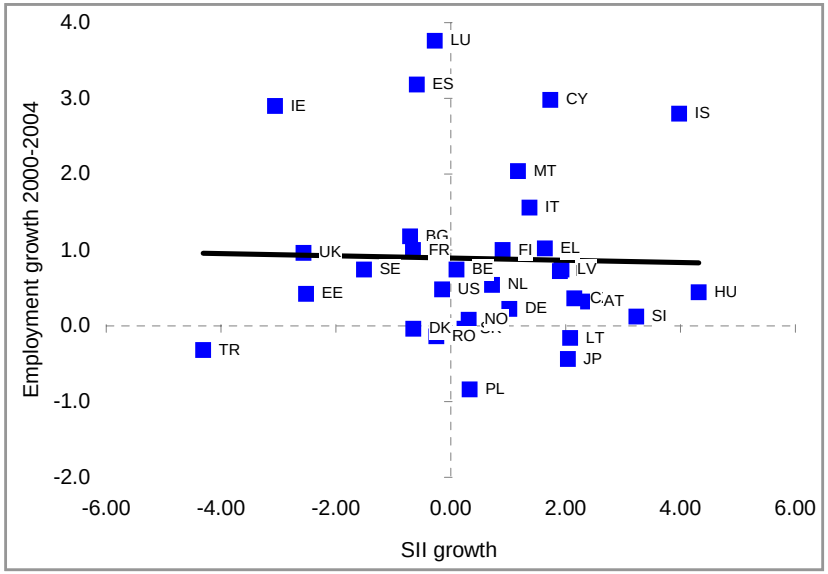


Figure 13 SII growth and employment growth



2.4 INNOVATION AND EMPLOYMENT

More innovative countries seem to have lower unemployment rates than less innovative countries. But for the innovation leaders, it seems that they have passed beyond a certain threshold level, as among these countries being even more innovative seems to lead to slightly higher unemployment rates (Figure 10).

Innovation performance could however have a positive impact on the decrease of unemployment. As shown by Figure 11, on average there is no statistical correlation between the SII and the 2000-2004 decrease of the unemployment rate.

Innovation performance and the average annual growth of employment between 2000 and 2004 do not appear to be correlated. As shown in Figure 12, the most innovative countries have all experienced average employment growth. It is the median performers who have experienced the fastest employment growth. Employment growth and the IP growth are not correlated at all (Figure 13).

2.5 RESEARCH AND GDP PER CAPITA

Both growth theory and management literature see R&D as an investment in knowledge or absorptive capacity and thus as a contributor to economic growth. Econometric analyses usually use the accumulated stock of R&D as one of the dependent variables in the regression equation[4]. Time series data for R&D expenditures in the EIS database are too short to permit the construction of R&D capital stocks. In this section we thus focus on more simple direct correlations between R&D expenditures and economic performance.

Table 3 shows correlation results between R&D expenditures (GERD) as a % of GDP and per capita GDP for various time lags. Time lags are simply derived as the difference between the year for per capita GDP and the year for the R&D intensity. The largest lag is 13 years between GERD in 1993 and per capita GDP in 2006. All correlation coefficients are significant at the 1% level. As the number of observations differs over time, one cannot directly compare these coefficients over time. The high correlation coefficients in 1996 are most likely due to the fact that for less countries R&D data are not available as compared to the years after 1996.

It is generally expected that is takes time for R&D investments to have a profound impact on economic performance. One would expect that the size of the correlations coefficients in Table 3 could identify the time lag(s) of R&D investments. However, as the coefficients do not peak in a particular year, it is not possible from Table 3 to identify after which period of time R&D expenditures impact on per capita GDP.

[4] Cf. Mohnen, P., "The importance of R&D: Is the Barcelona 3% a reasonable target?, Inaugural Lecture Maastricht University, May 2005 (http://www.unimaas.nl/bestand.asp?id=3826).

Table 3 Correlation between R&D (GERD) and per capita GDP

		GDP2002	GDP2003	GDP2004	GDP2005	GDP2006
GERD1993	Pearson Correlation	.574(**)	.570(**)	.581(**)	.576(**)	.575(**)
	Sig. (2-tailed)	.007	.007	.006	.006	.006
	N	21	21	21	21	21
GERD1994	Pearson Correlation	.712(**)	.712(**)	.722(**)	.717(**)	.717(**)
	Sig. (2-tailed)	.001	.001	.001	.001	.001
	N	17	17	17	17	17
GERD1995	Pearson Correlation	.733(**)	.734(**)	.742(**)	.740(**)	.738(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	25	25	25	25	25
GERD1996	Pearson Correlation	.832(**)	.830(**)	.837(**)	.834(**)	.830(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	21	21	21	21	21
GERD1997	Pearson Correlation	.737(**)	.737(**)	.745(**)	.743(**)	.740(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	26	26	26	26	26
GERD1998	Pearson Correlation	.772(**)	.774(**)	.781(**)	.780(**)	.777(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	27	27	27	27	27
GERD1999	Pearson Correlation	.736(**)	.738(**)	.746(**)	.745(**)	.741(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD2000	Pearson Correlation	.684(**)	.680(**)	.685(**)	.682(**)	.674(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	26	26	26	26	26
GERD2001	Pearson Correlation	.701(**)	.703(**)	.711(**)	.711(**)	.706(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD2002	Pearson Correlation	.740(**)	.745(**)	.754(**)	.755(**)	.751(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD2003	Pearson Correlation	.636(**)	.634(**)	.640(**)	.639(**)	.632(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 4 gives similar regression results but now for a core group of 29 countries[5] for which we either have full R&D data availability for 1998-2003 or for missing R&D data could easily by imputed[6]. All correlation coefficients are significant at the 1% level and fall within the range 0.701 to 0.755. The differences in the correlation coefficients are too small to determine the time lag of R&D expenditures.

[5] These countries are Belgium, Czech Republic, Denmark, Germany, Estonia, Greece, Spain, France, Ireland, Italy, Cyprus, Latvia, Lithuania, Hungary, Netherlands, Poland, Portugal, Slovenia, SK, FI, SE, UK, BG, RO, TR, IS, NO, US and JP.

[6] Imputation for in-between years is done by taking the average of the year before and after the missing year. Imputation for end-of-period years is done by taking the value of the year before.

Table 4 Correlation between R&D (GERD) and per capita GDP – core country sample

		GDP2002	GDP2003	GDP2004	GDP2005	GDP2006
GERD1998	Pearson Correlation	.744(**)	.746(**)	.755(**)	.753(**)	.750(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD1999	Pearson Correlation	.736(**)	.738(**)	.746(**)	.745(**)	.741(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD2000	Pearson Correlation	.721(**)	.723(**)	.731(**)	.730(**)	.725(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD2001	Pearson Correlation	.701(**)	.703(**)	.711(**)	.711(**)	.706(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD2002	Pearson Correlation	.708(**)	.710(**)	.717(**)	.718(**)	.712(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
GERD2003	Pearson Correlation	.726(**)	.729(**)	.738(**)	.738(**)	.733(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 5 shows correlation results between public R&D expenditures (PUBRD) as a % of GDP and per capita GDP for the core group of 29 countries[7]. For all years correlation coefficients are significant. Table 6 shows correlation results between business R&D expenditures (BERD) as a % of GDP and per capita GDP for the core group of 29 countries[8]. All correlation coefficients are significant at the 1% level.

[7] Annex Table 1 gives correlation results for the full country sample.

[8] Annex Table 2 gives correlation results for the full country sample.

Table 5 Correlation between Public R&D (PUBRD) and per capita GDP – core country sample

		GDP2002	GDP2003	GDP2004	GDP2005	GDP2006
PUBRD1998	Pearson Correlation	.630(**)	.626(**)	.626(**)	.627(**)	.619(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
PUBRD1999	Pearson Correlation	.619(**)	.615(**)	.616(**)	.616(**)	.608(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
PUBRD2000	Pearson Correlation	.634(**)	.631(**)	.632(**)	.632(**)	.623(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
PUBRD2001	Pearson Correlation	.616(**)	.613(**)	.614(**)	.614(**)	.604(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	29	29	29	29	29
PUBRD2002	Pearson Correlation	.610(**)	.607(**)	.608(**)	.610(**)	.601(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	29	29	29	29	29
PUBRD2003	Pearson Correlation	.665(**)	.664(**)	.667(**)	.669(**)	.661(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 6 Correlation between Business R&D BERD) and per capita GDP – core country sample

		GDP2002	GDP2003	GDP2004	GDP2005	GDP2006
BERD1998	Pearson Correlation	.708(**)	.712(**)	.723(**)	.721(**)	.720(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD1999	Pearson Correlation	.720(**)	.724(**)	.734(**)	.732(**)	.730(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD2000	Pearson Correlation	.710(**)	.714(**)	.723(**)	.723(**)	.720(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD2001	Pearson Correlation	.693(**)	.697(**)	.706(**)	.706(**)	.703(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD2002	Pearson Correlation	.702(**)	.706(**)	.715(**)	.715(**)	.711(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD2003	Pearson Correlation	.711(**)	.716(**)	.726(**)	.726(**)	.722(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29

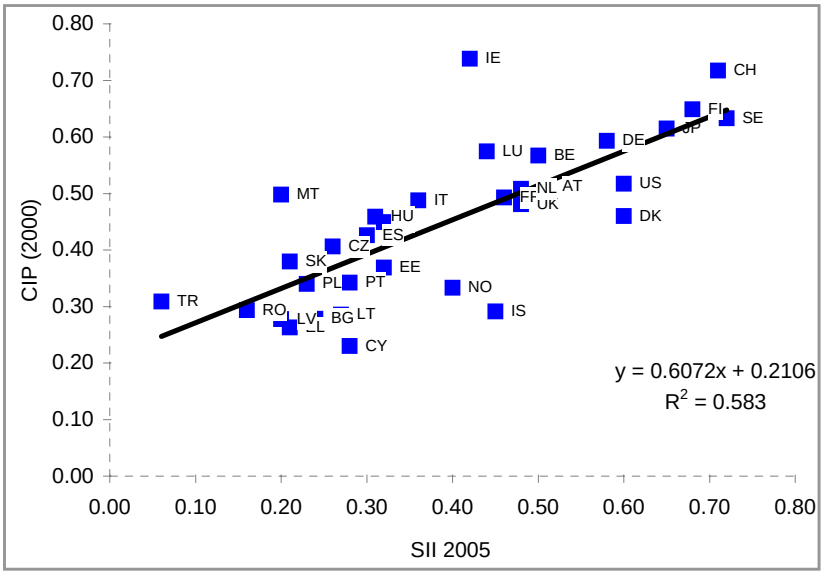
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

3. INNOVATION PERFORMANCE AND COMPETITIVE INDUSTRIAL PERFORMANCE INDEX

The UNIDO Industrial Development Scoreboard[9] focuses on benchmarking 155 countries in terms of their national ability to produce manufactures competitively and in terms of structural factors affecting their industrial capabilities. Four performance indicators – manufacturing value-added per capita, manufactured exports per capita, industrialization intensity (the arithmetic mean of the share of manufacturing value-added in GDP and the share of medium-high-tech activities in manufacturing value-added), and export quality (the arithmetic mean of the share of manufactures in total exports and the share of medium-high-tech products in manufactured exports) – were used to calculate a composite indicator measuring industrial performance: the Competitive Industrial Performance index (CIP).

Countries performing well on innovation performance as measured by their 2005 Summary Innovation Index (SII) also perform well on their industrial performance (Figure 14). As the SII is biased towards measuring (technical) innovation, it hardly comes as a surprise that industrial performance and innovation performance are significantly and positively correlated.

Figure 14 SII ad Competitive Industrial Performance index



[9] http://www.unido.org

4. AN ANALYSIS AT THE SECTOR LEVEL[10]

Innovation is assumed to be one of the drivers of economic growth. However, at the country level it is hard to find statistical evidence for this assumption. One explanation for not finding a significant positive correlation between innovation and economic growth at the country level is the fact that at the country level there are other more important drivers of economic growth. An analysis at the sector should be better able to reveal any positive impact of innovation on a sector's economic performance.

A composite innovation sector index (ISI) has been calculated for 25 sectors using innovation data for 12 indicators. After controlling for country-specific and sector-specific effects we do find a significant and positive correlation between the ISI and economic performance. Innovative performance at sector level and labour productivity growth as measured by the 1998-2000 growth rate of turnover per employee are positively correlated. More innovative sectors on average tend to have higher growth rates of labour productivity.

Table 7 Regressions results for simple correlations between innovation indicators and economic performance

	1998-2000 Labour productivity per person (turnover per employee) growth rate	Adjusted R-square
ISI – 25 sectors, 15 countries (no dummies)	-1.256 (-0.201)	-0.003
ISI – 25 sectors, 15 countries (country dummies)	1.742 (0.291)	0.280
ISI – 25 sectors, 15 countries (sector dummies)	9.949 (0.950)	-0.016
ISI – 25 sectors, 15 countries (country and sector dummies)	23.488 * (1.814)	0.292

t-value in parentheses

***/**/* Correlation is significant at the 1%-level/5%-level/ 10%-level. ISI = Innovation Sector Index.

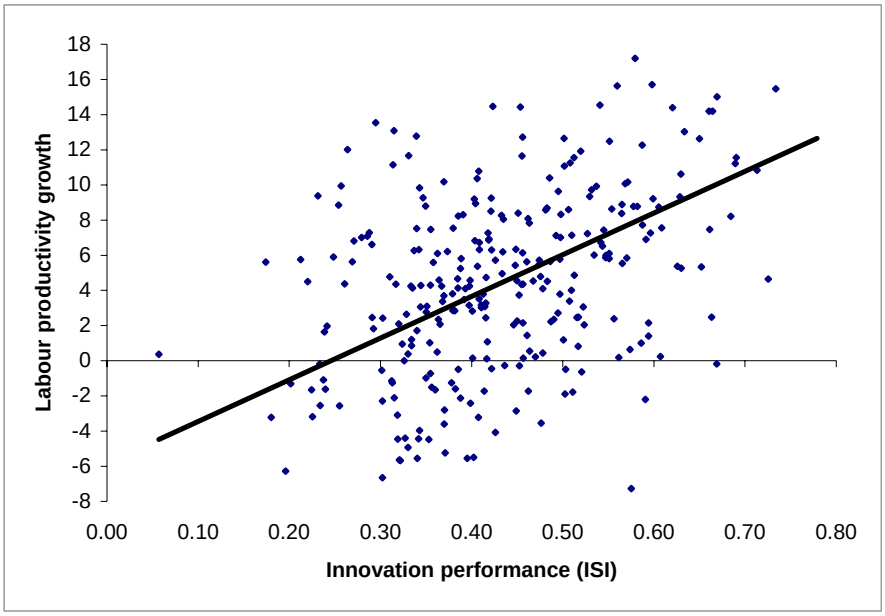
Table 7 summarizes the regression results for 4 simple linear regressions between innovation performance and the 1998-2000 growth rate of labour productivity. Labour productivity growth has been calculated using 1998 and 2000 CIS-3[11] data for turnover per employee. A direct regression between labour productivity growth and ISI shows no significant results. An explanation for this result may be differences in business cycles between countries and between sectors. We therefore introduce sector and country dummies, which should capture country specific and sector specific effects. The single introduction of country dummies does not lead to a more significant correlation coefficient. Apparently differences in business cycles across countries are as such not able to explain differences between sectors in their economic performance. The single introduction of sector dummies has a stronger impact raising the level of significance but to a level still being insignificant. Differences in business cycles across sectors are thus also not able to explain differences between sectors in their economic performance.

[10] This section is derived from section 3.4 from the EIS 2005 report on European Sector Innovation Scoreboards (http://trendchart.cordis.lu/scoreboards/scoreboard2005/).

[11] Community Innovation Survey

However, the introduction of both country and sector dummies shows a significant positive correlation between innovation and economic performance at the sector level. More innovative sectors thus tend to have higher growth rates of labour productivity, after controlling for both country-specific and sector-specific effects. Figure 15 shows a scatter plot between innovation performance on the horizontal axis and economic performance on the vertical axis, where the latter has been adjusted for country- and sector-effects by adding the regression coefficients for country and sector dummies.

Figure 15 Innovation and economic performance at the sector level



5. CONCLUSIONS

At country level statistical evidence for a positive correlation between innovation and economic performance is weak. At sector level statistical evidence is already more relevant, but it is at firm level that we expect to find highly significant correlations between innovation and economic performance. With the release in 2006 of micro-aggregated CIS3 data and possibly also CIS 4 data by Eurostat an opportunity arises to explore this relationship in more detail.

Annex Table 1 Correlation between Public R&D (PUBRD) and per capita GDP – full sample

		GDP2002	GDP2003	GDP2004	GDP2005	GDP2006
PUBRD1993	Pearson Correlation	.407	.393	.391	.392	.386
	Sig. (2-tailed)	.067	.078	.079	.079	.084
	N	21	21	21	21	21
PUBRD1994	Pearson Correlation	.463	.454	.452	.453	.447
	Sig. (2-tailed)	.061	.067	.069	.068	.072
	N	17	17	17	17	17
PUBRD1995	Pearson Correlation	.661(**)	.652(**)	.650(**)	.649(**)	.642(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	25	25	25	25	25
PUBRD1996	Pearson Correlation	.692(**)	.686(**)	.683(**)	.677(**)	.672(**)
	Sig. (2-tailed)	.001	.001	.001	.001	.001
	N	21	21	21	21	21
PUBRD1997	Pearson Correlation	.659(**)	.651(**)	.647(**)	.646(**)	.637(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	26	26	26	26	26
PUBRD1998	Pearson Correlation	.628(**)	.625(**)	.625(**)	.627(**)	.619(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	27	27	27	27	27
PUBRD1999	Pearson Correlation	.619(**)	.615(**)	.616(**)	.616(**)	.608(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
PUBRD2000	Pearson Correlation	.325	.315	.313	.310	.297
	Sig. (2-tailed)	.106	.117	.119	.123	.140
	N	26	26	26	26	26
PUBRD2001	Pearson Correlation	.616(**)	.613(**)	.614(**)	.614(**)	.604(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	29	29	29	29	29
PUBRD2002	Pearson Correlation	.600(**)	.599(**)	.602(**)	.606(**)	.598(**)
	Sig. (2-tailed)	.001	.001	.001	.000	.001
	N	29	29	29	29	29
PUBRD2003	Pearson Correlation	.404(*)	.395(*)	.397(*)	.397(*)	.388(*)
	Sig. (2-tailed)	.030	.034	.033	.033	.038
	N	29	29	29	29	29

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

For all years except 1993, 1994 and 2000 correlation coefficients are significant. For 1993 and 1994 an explanation could be that the time lag is too long. For 2000 a simple explanation is the fact that Luxembourg is included whereas there are no R&D data for this country for any other year except 2003. Luxembourg combines peak performance in per capita GDP with poor performance in R&D spending.

Annex Table 2 Correlation between Business R&D BERD) and per capita GDP – full sample

		GDP2002	GDP2003	GDP2004	GDP2005	GDP2006
BERD1993	Pearson Correlation	.550(**)	.551(**)	.565(**)	.559(**)	.558(**)
	Sig. (2-tailed)	.010	.010	.008	.008	.009
	N	21	21	21	21	21
BERD1994	Pearson Correlation	.701(**)	.704(**)	.717(**)	.711(**)	.713(**)
	Sig. (2-tailed)	.002	.002	.001	.001	.001
	N	17	17	17	17	17
BERD1995	Pearson Correlation	.688(**)	.692(**)	.703(**)	.700(**)	.702(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	25	25	25	25	25
BERD1996	Pearson Correlation	.819(**)	.815(**)	.825(**)	.823(**)	.820(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	22	22	22	22	22
BERD1997	Pearson Correlation	.699(**)	.702(**)	.713(**)	.710(**)	.710(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	26	26	26	26	26
BERD1998	Pearson Correlation	.744(**)	.747(**)	.757(**)	.755(**)	.754(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	27	27	27	27	27
BERD1999	Pearson Correlation	.720(**)	.724(**)	.734(**)	.732(**)	.730(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD2000	Pearson Correlation	.756(**)	.755(**)	.762(**)	.759(**)	.753(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	26	26	26	26	26
BERD2001	Pearson Correlation	.693(**)	.697(**)	.706(**)	.706(**)	.703(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD2002	Pearson Correlation	.748(**)	.754(**)	.766(**)	.766(**)	.763(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	29	29	29	29	29
BERD2003	Pearson Correlation	.664(**)	.665(**)	.674(**)	.673(**)	.668(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	30	30	30	30	30

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).